Arch. Environ. Contam. Toxicol. 19, 731–747 (1990)

Archives of Environmental Contamination and Toxicology

National Contaminant Biomonitoring Program: Concentrations of Arsenic, Cadmium, Copper, Lead, Mercury, Selenium, and Zinc in U.S. Freshwater Fish, 1976–1984

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Abstract. From late 1984 to early 1985, the U.S. Fish and Wildlife Service collected a total of 315 composite samples of whole fish from 109 stations nationwide, which were analyzed for arsenic, cadmium, copper, lead, mercury, selenium, and zinc. Geometric mean, maximum, and 85th percentile concentrations (μg/g wet weight) for 1984 samples were as follows: arsenic—0.14, 1.5, 0.27; cadmium—0.03, 0.22, 0.05; copper—0.65, 23.1, 1.0; mercury—0.10, 0.37, 0.17; lead—0.11, 4.88, 0.22; selenium—0.42, 2.30, 0.73; and zinc—21.7, 118.4, 34.2. The mean concentrations of selenium and lead were significantly lower than in the previous NCBP collection (1980–81). Mean concentrations of arsenic and cadmium also declined significantly between 1976, when elemental contaminants in fish were first measured in the NCBP, and 1984. Of greatest significance, lead concentrations declined steadily from 1976 to 1984, suggesting that regulatory measures have successfully reduced the influx of lead to the aquatic environment.

The National Contaminant Biomonitoring Program (NCBP) is maintained by the U.S. Fish and Wildlife Service (FWS) to document temporal and geographic trends in concentrations of persistent environmental contaminants that may threaten fish and wildlife. The NCBP also provides information on the success of regulatory actions intended to reduce environmental concentrations of toxic materials. The NCBP originated in 1967 as the FWS segment of the National Pesticide Monitoring Program, a multi-agency monitoring effort by the member agencies of the Federal Committee on Pest Control (Johnson *et al.* 1967). During 1967–84, FWS has periodically determined concentrations of potentially toxic elements and selected organochlorine chemicals in samples of fish and wildlife collected from nationwide networks of stations. The results for organochlorine chemical residues and elemental contaminants in freshwater fish collected in 1967–81 have already been reported (Henderson *et al.* 1969, 1971, 1972; Lowe *et al.* 1985; May and McKinney 1981; Schmitt *et al.* 1981, 1983, 1985; Walsh *et al.* 1977). Analytical results are presented here for concentrations of arsenic, cadmium, copper, lead, mercury, selenium and zinc in freshwater fish collected in 1984 and early 1985 (here termed 1984), and temporal and geographic trends are evaluated by comparison with earlier findings.

Materials and Methods

Sample Collection

Fish were collected from 112 stations at key points in major rivers throughout the United States and in the Great Lakes (Figure 1; Table 1). A total of 321 composite samples, each comprising 3 to 5 whole, adult specimens of a single species, were collected in fall and winter 1984 and early spring 1985 (Table 1). Collaborators were asked to collect three samples at each station—two of a representative bottom-feeding species, and one of a representative predatory species. Preferred fish species and methods of collecting, shipping, archiving, and preparing samples were described by Schmitt *et al.* (1981, 1983, 1985), except that collections were made at all the stations in the fall and winter of 1984-85. In previous years, collections were made at about half the stations in the fall of even-numbered years and at the rest in the fall of odd-numbered years, thus requiring more than 2 yr for the completion of a collection cycle. Fish were shipped to the laboratory frozen in dry ice and stored in a freezer until prepared for analysis.

Sample Preparation

Individual frozen fish were cut into cubes with a food service bandsaw. The cubes from all the specimens constituting a sample were then mixed together and ground twice in a meat grinder, as described by Lowe *et al.* (1985). Subsamples of about 125 g were transferred to crystallizing dishes (80 × 40 mm) and lyophilized to constant weight in an FTS Systems®[1] freeze dryer. Dried samples were transferred to polyethylene bags and pulverized with a rubber mallet to redistribute tissues.The moisture content of each sample was determined from a separate 10-g aliquot of ground tissue dried

[1] Use of trade names does not constitute government endorsement of products

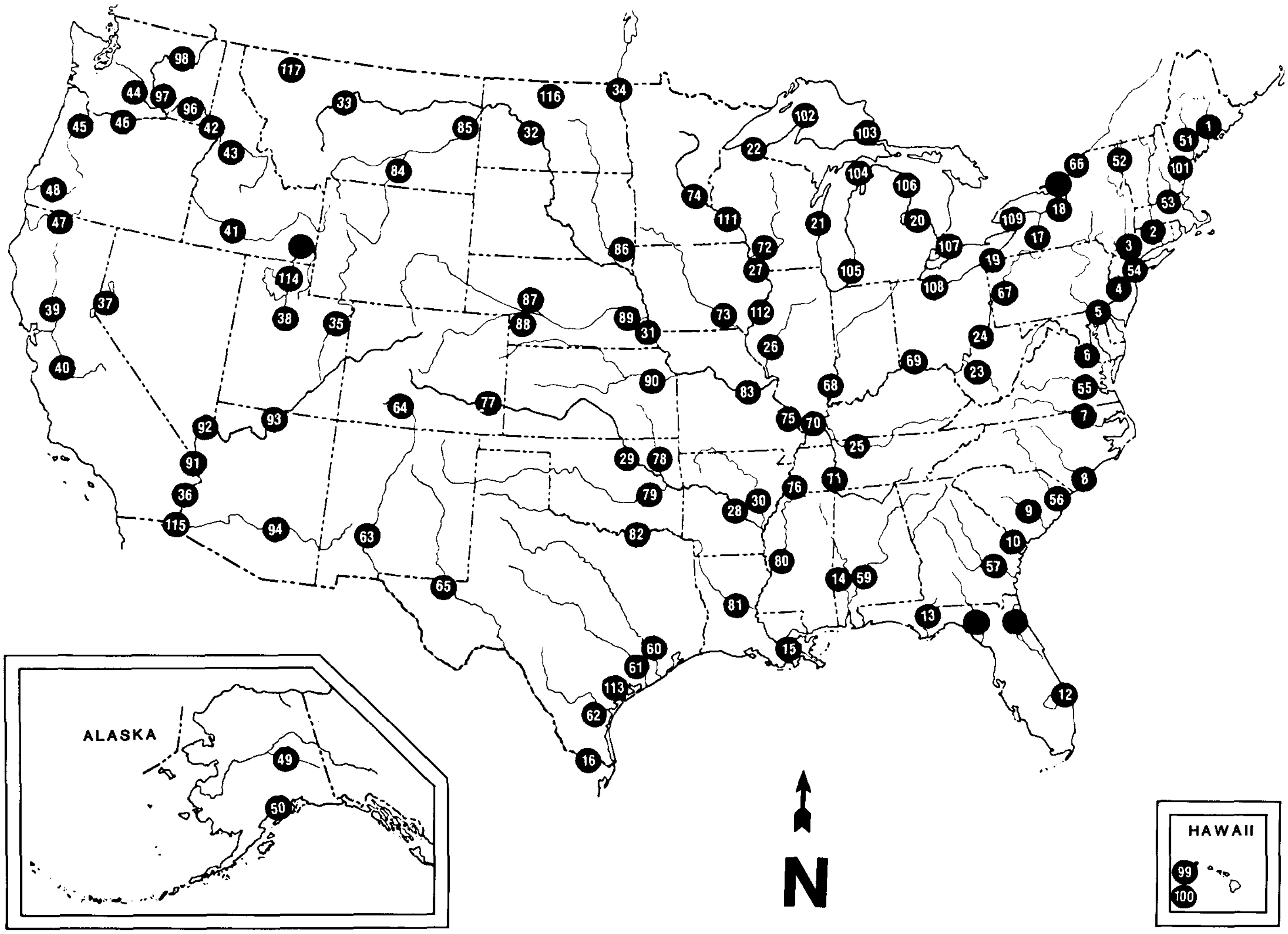

Fig. 1. National Contaminant Biomonitoring Program (NCBP) stations (numbered circles) where fish were collected for analysis in 1984. Solid circles represent inactive stations

at 105°C to constant weight in a C. W. Brabender Moisture/Volatiles Tester.

Reagents

Reagent-grade nitric and hydrochloric acids (J. T. Baker), further purified by sub-boiling distillation, were used for digesting and diluting samples and standards. Atomic spectral standards (Baker) were used for preparing standard curves and fortifying samples for accuracy evaluation. Ashing agent [40% $Mg(NO_3)_2 \cdot 6H_2O$ w/v], used for digestion of samples for arsenic and selenium determinations, was prepared with ACS-grade (Mallinckrodt) reagents. Sodium tetrahydridoborate (98%, pellet, Alfa Products) was prepared as a 0.6% (w/v) solution for selenium determination and a 1.0% solution for arsenic, each 0.5% (w/v) in NaOH. Reducing agents used for determination of mercury, 10% $SnCl_2$ (w/v) in 10% HCl (v/v) and 1.5% NH_2OH-HCl (w/v), were from J. T. Baker.

Digestion

Digestion of samples to be analyzed for cadmium, copper, lead, mercury, and zinc was similar to that described by Lowe *et al.* (1985); however, 5 mL was substituted for 3 mL of concentrated, sub-boiled nitric acid to digest each sample, and the final dilution volume was 100 mL instead of 50 mL. Samples were digested for arsenic and selenium determination with a combined nitric acid wet ash and magnesium nitrate dry ash procedure, as described by Brumbaugh and Walther (1989).

Analyses

A Perkin-Elmer Model 5000 atomic absorption spectrophotometer was used for all determinations. For cadmium, copper, and lead, we used an HGA-500 graphite furnace and AS-40 autosampler (Perkin-Elmer). The use of stabilized temperature platform furnace conditions for atomization (Slavin 1984) and measurement by peak area reduced interferences from sample solutions and permitted direct determination by comparison to acid-matched standards of up to 6, 150, and 60 ng/mL for cadmium, copper, and lead, respectively. Mercury was determined by the cold-vapor atomic absorption method with a Varian VGA-76 vapor generator connected to a Pyrex® glass absorption cell (May and McKinney 1981). A prereductant of 1.5% NH_2OH-HCl and primary reductant of 10% $SnCl_2$ were used in the vapor generator to produce the mercury vapor. Arsenic and selenium were determined by hydride-generation

Table 1. Freshwater fish collection stations, National Contaminant Biomonitoring Program (NCBP)

Station	River or lake	Location
1	Penobscot River	Old Town, ME
2	Connecticut River	Windsor Locks, CT
3[a]	Hudson River	Poughkeepsie, NY
4	Delaware River	Trenton, NJ
5	Susquehanna River	Conowingo Dam, MD
6	Potomac River	Little Falls, ND
7	Roanoke River	Roanoke Rapids, NC
8	Cape Fear River	Elizabethtown, NC
9	Cooper River	Lake Moultrie, SC
10	Savannah River	Savannah, GA
11[b]	St. Johns River	Welaka, FL
12	St. Lucie Canal	Indiantown, FL
13	Apalachicola River	J. Woodruff Dam, FL
14	Tombigbee River	McIntosh, AL
15	Mississippi River	Luling, LA
16	Rio Grande	Mission, TX
17	Genessee River	Scottsville, NY
18	Lake Ontario	Port Ontario, NY
19	Lake Erie	Erie, PA
20	Lake Huron (Saginaw Bay)	Bay Port, MI
21	Lake Michigan	Sheboygan, WI
22	Lake Superior	Bayfield, WI
23	Kanawha River	Winfield, WV
24	Ohio River	Marietta, OH
25	Cumberland River	Clarksville, TN
26	Illinois River	Beardstown, IL
27	Mississippi River	Guttenburg, IA
28	Arkansas River	Pine Bluff, AR
29	Arkansas River	Keystone Reservoir, OK
30	White River	Devalls Bluff, AR
31	Missouri River	Nebraska City, NE
32	Missouri River	Garrison Dam, ND
33	Missouri River	Great Falls, MT
34	Red River of the North	Noyes, MN
35	Green River	Vernal, UT
36	Colorado River	Lake Martinez, AZ
37	Truckee River	Fernley, NV
38	Utah Lake	Provo, UT
39	Sacramento River	Knight's Landing, CA
40	San Joaquin River	Los Banos, CA
41	Snake River	Hagerman, ID
42	Snake River	Lewiston, ID
43	Salmon River	Riggins, ID
44	Yakima River	Granger, WA
45	Willamette River	Oregon City, OR
46	Columbia River	Cascade Locks, OR
47	Klamath River	Hornbrook, CA
48	Rogue River	Goldray Dam, OR
49	Chena River	Fairbanks, AK
50	Kenai River	Soldatna, AK
51	Kennebec River	Hinckley, ME
52[a]	Lake Champlain	Burlington, VT
53	Merrimack River	Lowell, MA
54	Raritan River	Highland Park, NJ
55	James River	Richmond, VA
56	Pee Dee River	Johnsonville, SC
57	Altamaha River	Doctortown, GA
58[b]	Suwanee River	Old Town, FL
59	Alabama River	Chrysler, AL
60	Brazos River	Richmond, TX
61[c]	Colorado River	Wharton, TX
62	Nueces River	Mathis, TX
63	Rio Grande	Elephant Butte, NM
64	Rio Grande	Alamosa, CO
65	Pecos River	Red Bluff Lake, TX
66[a]	St. Lawrence River	Massena, NY
67	Allegheny River	Natrona, PA
68	Wabash River	New Harmony, IN
69	Ohio River	Cincinnati, OH
70	Ohio River	Metropolis, IL
71	Tennessee River	Savannah, TN
72	Wisconsin River	Woodman, WI
73	Des Moines River	Keosauqua, IA
74	Mississippi River	Little Falls, MN
75	Mississippi River	Cape Girardeau, MO
76	Mississippi River	Memphis, TN
77	Arkansas River	John Martin Reservoir, CO
78	Verdigris River	Oologah, OK
79	Canadian River	Eufaula, OK
80	Yazoo River	Redwood, MS
81	Red River	Alexandria, LA
82	Red River	Lake Texoma, OK
83	Missouri River	Hermann, MO
84	Big Horn River	Hardin, MT
85	Yellowstone River	Sidney, MT
86	James River	Olivet, SD
87	North Platte River	Lake McConaughy, NE
88	South Platte River	Brule, NE
89	Platte River	Louisville, NE
90	Kansas River	Bonner Springs, KS
91	Colorado River	Lake Havasu, AZ
92	Colorado River	Lake Mead, AZ
93	Colorado River	Lake Powell, AZ
94	Gila River	San Carlos Reservoir, AZ
95[b]	Bear River	Preston, ID
96	Snake River	Ice Harbor Dam, WA
97	Columbia River	Pasco, WA
98	Columbia River	Grand Coulee, WA
99	Waikele Stream	Waipahu, HI
100	Manoa Stream	Honolulu, HI
101	Androscoggin River	Lewiston, ME
102	Lake Superior	Keeweenaw Point, MI
103	Lake Superior	Whitefish Point, MI
104	Lake Michigan	Beaver Island, MI
105	Lake Michigan	Saugatuck, MI
106	Lake Huron	Alpena, MI
107	Lake St. Clair	Mt. Clemens, MI
108	Lake Erie	Port Clinton, OH
109	Lake Ontario	Roosevelt Beach, NY
110[b]	Lake Ontario	Cape Vincent, NY
111	Mississippi River	Lake City, MN
112	Mississippi River	Dubuque, IA
113	San Antonio River	McFaddin, TX
114	Bear River	Brigham City, UT
115	Colorado River	Yuma, AZ
116	Souris River	Upham, ND
117	Flathead River	Creston, MT

[a] Not analyzed in 1984
[b] Inactive station
[c] Not collected in 1984

atomic absorption with a VGA-76 vapor generator (Brumbaugh and Walther 1989). Zinc was determined by flame atomic absorption (Lowe *et al.* 1985).

Quality Assurance

Quality control samples, analyzed to estimate accuracy and precision of results, included biological reference materials, spiked (fortified) samples, triplicate determinations, and procedural blanks. Reference materials included U.S. National Bureau of Standards (NBS) oyster, tuna, and liver, and an in-house reference fish sample—a composite sample of whole striped bass (*Morone saxatilis*) collected from the Hudson River, NY, in 1981. The accepted range for the in-house fish, which is more representative of the sample matrix than the NBS materials, is based on multiple independent determinations from several reputable laboratories. Concentrations measured for the reference samples agreed well with reported values; mean concentrations measured were within 10% of certified or recommended ranges for all materials and elements. Mean recovery of pre-digestion spikes, which included organometallic analyte forms, ranged from 93.8% for selenomethionine to 104.4% for elemental zinc [with relative standard deviations (RSD's) of 4.3–11.5%].

To gauge the overall precision of elemental determinations, sixteen samples were selected for triplicate analysis; however, results from determinations near or below detection limits were not included in the evaluation of precision due to the inherently high imprecision of measurements near the detection limit (American Chemical Society 1980). The mean RSD of each set of triplicate determinations was about 5% for all analytes except lead, for which it was 19.3%. The poor reproducibility for lead was probably due to the difficulty of homogenizing skin, scale, and bone (May and McKinney 1981), which accumulate high concentrations of this element (Varanasi and Markey 1978; Settle and Patterson 1980).

Procedural blanks were analyzed to check for contamination and to calculate the limit of detection (LOD) for each element and set of samples by the formula

$$\mathrm{LOD} = 3\,[\,S_b^2 + S_s^2\,]^{0.5}$$

where S_b^2 and S_s^2 are the variances of concentrations measured for procedural blanks and a low-level sample, respectively. The minimum and maximum LOD's for each element (μg/g, wet weight) were as follows: arsenic, 0.01 and 0.14; cadmium, 0.005 and 0.046; copper, 0.09 and 1.2; mercury, 0.01 and 0.05; lead, 0.03 and 0.59; selenium, 0.017 and 0.15; and zinc, 1.5 and 5.0.

Overall, the results for the quality control samples were within limits of acceptance established by our laboratory; details are available upon request.

Data Analysis and Data Set Composition

For analyses of temporal and geographic trends, results for the 1984 collection were pooled with previously reported data for 1976–81 (May and McKinney 1981; Lowe *et al.* 1985). To illustrate temporal trends, we compared the mean (after appropriate transformation) and maximum concentration for each collection period. Least-squares means, adjusted for the number of observations in each station-collection period cell, were examined throughout. Concentrations below the LOD were reported as "not detected" (Appendix A); however, a value of one-half the LOD was assigned for statistical computations (Kushner 1976). Concentrations were transformed [$\log_e$ (elemental concentration + 1.0)] before statistical analyses. Transformed values of concentrations were analyzed by analysis of variance (ANOVA) with a mixed two-way model. Differences among the collection-period means were examined and tested with Fisher's protected least-significant-difference (LSD) test, and the Mann-Kendall test for trend was used to test the significance of changes in elemental concentrations at individual stations. Further comparisons were made by computing the 85th percentiles of the geometric station means and comparing these and the maximum concentrations with corresponding values for previous collection periods as indicators of trends at the stations with the highest concentrations for each element. The Mann-Kendall test was selected on the basis of its relative insensitivity to (1) missing observations, (2) deviations from assumptions regarding distributions, and (3) the presence of many zero or non-detected values (Gilbert 1967). Schmitt (1981) and Schmitt *et al.* (1981) described the other procedures in more detail and discussed their applicability to contaminant monitoring data. A significance level of $P \leq 0.05$ was used for all statistical tests, unless otherwise specified.

Of the samples collected in 1984, 315 from 109 stations were analyzed (samples from Stations 3, 52, and 66 were inadvertently destroyed during processing). The 315 samples included 47 taxa (Appendix A). As in previous years (May and McKinney 1981; Lowe *et al.* 1985), common carp (*Cyprinus carpio*), white sucker (*Catostomus commersoni*), and largemouth bass (*Micropterus salmoides*), and their respective families (Cyprinidae, Catostomidae, and Centrarchidae), were the most frequently collected taxa. For lead, cadmium, mercury, and arsenic, data from 84 stations spanned four collection periods (1976–77, 1978–79, 1980–81, and 1984). The 936 samples in this subset of stations, which contained representatives of 62 taxa, were used in most of the analyses of temporal trends; trends were examined independently at 85 stations. In species composition, the 84- and 85-station subsets were similar to the complete data set, and samples from 53 of the stations included at least one species obtained in all four collection periods. At 89% of the 109 stations sampled in 1976–84, five or fewer species have been collected. Statistical analyses for copper, selenium, and zinc—elements that were added in later years of the NCBP—were performed on subsets of these 84- and 85-station data sets spanning three collection periods (1978–79 to 1984).

Results and Discussion

Trends in Elemental Concentrations

Lead: Nationally, the geometric mean concentration of lead in fish declined significantly ($P < 0.01$) from 1976–77 to 1984 (Table 2), continuing a decrease that became evident in 1978–79 (Lowe *et al.* 1985). Mean concentrations of lead had not changed from 1972 to 1976–77 (May and McKinney 1981). The 85th percentile concentration for lead also declined steadily from 1976–77 to 1984, the value for 1984 being about 50% of that for 1976–77 (Table 3).

Among the 85 stations tested for trends from 1976–77 to 1984, lead concentrations decreased significantly at 24, and there were no significant increases (Table 4). The 24 stations with declining lead concentrations included three at which concentrations were relatively high (exceeding the 85th percentile) in one or more of the three collection periods in 1976–81: Stations 53 (Merrimac R. at Lowell, MA), 98 (Columbia R. at Grand Coulee, WA), and 86 (James R. at Olivet, SD). At Station 98, which has historically been influenced by mining activities in Idaho and Washington, lead concentrations in largescale suckers (*Catostomus macrocheilus*) declined from 2.57 μg/g in 1976 (May and McKinney 1981) to 0.16–0.40 μg/g in 1984 (Appendix A).

Among the 28 stations not tested for trends (due to incom-

Table 2. Geometric mean concentrations (μg/g wet weight) of seven elements for the 1976–77, 1978–79, 1980–81, and 1984 collection periods, and significance tests for time-period main effects (as ANOVA *F*-values[a]). For each element (rows), values containing the same subscript letter are not significantly different. Data for 1976–77 from May and McKinney (1981) and for 1978–81 from Lowe *et al.* (1985)

	Collection period				
Element	1976–77	1978–79	1980–81	1984	F^a
Arsenic	0.27_a	0.16_b	0.15_b	0.14_b	42.98**
Cadmium	0.07_a	0.04_b	0.03_b	0.03_b	32.32**
Copper	—	0.82_a	0.65_b	0.65_b	9.75**
Mercury	0.12_a	0.12_a	0.12_a	0.10_a	2.00
Lead	0.28_a	0.19_b	0.17_b	0.11_c	25.39**
Selenium	—	0.48_a	0.46_a	0.42_b	5.79**
Zinc	—	23.8_a	21.4_b	21.7_b	4.22*

[a] df = 3, 249 for arsenic, cadmium, mercury, and lead; and 2, 166 for cadmium, selenium, and zinc: ** $P \leq 0.01$; * $P \leq 0.05$

plete data), no statistically significant changes from 1978–79 to 1980–81 were apparent (Lowe *et al.* 1985); however, concentrations of lead in goldfish (*Carassius auratus*) from Station 3 (Hudson R. at Poughkeepsie, NY) declined from 3.07–3.83 μg/g in 1976 (May and McKinney 1981) to 1.62–1.91 μg/g in 1978 and 1.12 μg/g in 1981 (Lowe *et al.* 1985). The Hudson River watershed contains significant natural and anthropogenic sources of lead (May and McKinney 1981; Rhoman 1985; Rhoman and Lilienthal 1987).

In 1984, concentrations of lead in fish were highest at many sites where they were high in past collection periods and where there have been no statistically significant changes in concentrations since 1976–77. These included Stations 99 and 100 (in Hawaii); 2 (Connecticut R. at Windsor Locks, CT); 54 (Raritan R. at Highland Park, NJ); and 107 (Lake St. Clair at Mount Clemens, MI; Fig. 2 and Table 4). The highest lead concentration in 1984 was in Cuban limia (*Limia culensis*) from Station 100, which has yielded the sample with the highest concentration in each previous NCBP collection that included this station (Table 3). Stations 19 (Lake Erie at Erie, PA), and 111 (Mississippi R. at Lake City, MN), have no history of elevated lead concentrations (May and McKinney 1981; Lowe *et al.* 1984); however, these stations were among those with the greatest 1984 geometric mean concentrations (Figure 2), because the concentration in one sample from each station was about 20-fold higher than that in the other two samples (Appendix A). At Stations 5 (Susquehanna R. at Conowingo Dam, MD), 47 (Klamath R. at Hornbrook, CA), and 64 (Rio Grande at Alamosa, CO), however, concentrations were comparatively high in at least two samples in 1984. Conversely, although lead concentrations were high at Station 85 (Yellowstone R. at Sidney, MT) in 1980–81 (Lowe *et al.* 1985), they were near background (<0.1 μg/g) in 1984 (Appendix A).

One could argue that the recent declines in lead concentrations noted for fish, as well as those reported for other media—water, sediment, and air (Smith *et al.* 1987; Alexander and Smith 1988; Trefry *et al.* 1985; Eisenreich *et al.* 1986)—have been influenced to an unknown degree by an overall reduction in the quantity of environmental lead acquired as "background" during the collection, processing, and analysis of samples (Settle and Patterson 1980; Schmitt and Finger 1987). In general, lead concentrations in whole fish, in contrast to those in fish muscle, are well above the levels at which samples would be susceptible to such contamination (Schmitt and Finger 1987), suggesting that the decline we have reported is truly representative of the magnitude to which lead concentrations in the aquatic environment fell between 1976–77 and 1984.

Cadmium: Nationally, the geometric mean concentration of cadmium in fish declined from 1976–77 to 1978–79, but did not change between 1978–79 and 1984 (Table 2). The rate of decline in the 85th percentile concentration also slowed after 1978–79; however, the maximum cadmium concentration in each collection period continued to decline through 1984 (Table 3).

From 1976–77 to 1984, cadmium concentrations declined significantly at 18 of the 85 stations examined individually for temporal trends, and there were no increases (Table 4). Among the stations showing evidence of declining concentrations, however, at only two were concentrations relatively high in previous collections: Stations 4 (Delaware R. at Trenton, NJ) and 78 (Verdigris R. at Oologah, OK). The lower Delaware River watershed is heavily urbanized and industrialized, and receives cadmium from a zinc smelter located on the Lehigh River in Pennsylvania (May and McKinney 1981). The Verdigris River drains part of the Tri-State Mining District, where lead, zinc, and cadmium were mined for many years and which contains abandoned mines and ore-processing facilities, as well as a zinc smelter located in Bartelsville, OK (May and McKinney 1981; Pita and Hyne 1975).

Concentrations of cadmium in the 1984 collection were highest at stations with historical evidence of contamination, but also included stations not previously identified as problems. New among those with high concentrations was Station 92 (Colorado R. at Lake Mead, NV), which had the highest geometric mean cadmium concentration measured in the 1984 collection (Figure 3); cadmium concentrations increased about 5-fold from 1979 to 1984, from 0.01–0.04 μg/g (Lowe *et al.* 1985) to 0.13–0.18 μg/g (Appendix A). No samples from Station 92 were analyzed in 1976–77, and this station was consequently not among the 85 analyzed for temporal trends. Conversely, at Station 93, which is located at the next impoundment upstream on the Colorado River (Lake Powell at Page, AZ), cadmium concentrations were relatively high in previous collections (May and McKinney 1981; Lowe *et al.* 1985), and remained so in 1984 (Figure 3; Table 2). Elevated concentrations of cadmium in fish from the Colorado River system have been attributed to mining activities in Colorado and Utah (May and McKinney 1981). The highest cadmium concentration in a single 1984 sample was in common carp from Station 107 (Lake St. Clair); however, the value (0.22 μg/g) was low compared with the maxima reported for previous collection periods (Table 3). Stations 2 (Connecticut R.) and 24 (Ohio R. at Marietta, OH) have also been identified in past collections as cadmium problem spots owing to mining, smelting, and other industrial activities (May and McKinney 1981; Lowe *et al.* 1985).

Table 3. Maximum and 85th percentile[a] concentrations (μg/g wet weight) of seven elements in whole fish, 1976–77 to 1984. Data for 1976–77 from May and McKinney (1981), and for 1978–79 and 1980–81 from Lowe *et al.* (1985)

Element and collection period	Maximum			85th percentile concn.[a]
	Concn.	Station number	Species	
Arsenic				
1976–77	2.93	21	Bloater	0.38
1978–79	2.08	21	Bloater	0.23
1980–81	1.69	21	Bloater	0.22
1984	1.50	21	Bloater	0.27
Cadmium				
1976–77	1.04	73	Common carp	0.11
1978–79	0.41	98	Largescale sucker	0.09
1980–81	0.35	78	Common carp	0.06
1984	0.22	107	Common carp	0.05
Copper				
1978–79	38.7	5[b]	White perch	1.1
1980–81	24.1	5[b]	White perch	0.9
1984	23.1	99	Mozambique tilapia	1.0
Mercury				
1976–77	0.85	107	Walleye	0.19
1978–79	1.09	46	Northern squawfish	0.18
1980–81	0.77	45	Northern squawfish	0.17
1984	0.37	56	Largemouth bass	0.17
Lead				
1976–77	4.93	100	Cuban limia	0.44
1978–79	6.73	100	Mozambique tilapia	0.32
1980–81	1.94	2[c]	White catfish	0.25
1984	4.88	100	Cuban limia	0.22
Selenium				
1976–77	2.87	84	Goldeye	0.82
1978–79	3.65	91	Common carp	0.70
1980–81	2.47	38	Common carp	0.71
1984	2.30	36	Common carp	0.73
Zinc				
1978–79	168.1	38	Common carp	46.3
1980–81	109.2	35	Common carp	40.1
1984	118.4	107	Common carp	34.2

[a] 85th percentile for the distribution of geometric station means
[b] Only Cuban limia were collected at Station 99 in 1978–79; no data for 1980–81
[c] No data for Station 100 in 1980–81

The rest of the stations with high concentrations (79, 94, 109, 25, and 71), however, were first identified in the 1984 collection. Although the mean concentrations (<0.10 μg/g) at these sites were high compared with those at other stations, they were nevertheless lower than levels identified as "high" in the past. Station 3 (Hudson R.), where cadmium concentrations in goldfish were also high in the past, was not sampled in 1984; however, Lowe *et al.* (1985) reported that concentrations had not changed between 1976 and 1980. At Station 98 (Columbia R.), cadmium concentrations in largescale suckers were 0.05–0.17 μg/g in 1984 (Appendix A), compared with 0.18–0.41 μg/g in 1976–80 (May and McKinney 1981; Lowe *et al.* 1985). Concentrations in the other species collected at Station 98 (walleye, *Stizostedion vitreum vitreum,* and yellow perch, *Perca flavescens*) have remained low, perhaps explaining the lack of statistical significance of the downward trend in the mean concentration at this station (Table 4).

Lowe *et al.* (1985) noted that concentrations of zinc were significantly higher in common carp than in any other species collected in 1978–81. As judged by the 1984 results, it also appears that common carp accumulate cadmium more readily than other species analyzed; of the 31 samples with the highest concentrations (uppermost 15%), all but 7 were common carp, and concentrations were always higher in common carp than in the other species collected with them.

Mercury: The national geometric mean concentration of mercury in fish did not change during 1976–84 (Table 2), after a period of decline from 1972 to 76 (May and McKinney 1981). Similarly, neither the 85th percentile nor the maximum concentrations encountered in each collection period for mercury changed appreciably between 1976–77 and 1984 (Table 3). All but one of the stations at which mercury concentrations were highest in 1984 (Figure 4) were previously identified as influenced by open-cell chloralkali plants and paper mills (May and McKinney 1981).

Table 4. Numbers and (in parentheses) identity of stations at which elemental concentrations increased or decreased significantly ($P \leq 0.05$, $n = 85$, Mann-Kendall test for trend) from 1976–77 (1978–79 for copper and zinc) to 1984

	Direction of change in concentration			
	Increase		Decrease	
Element	No. of stations	Station nos.	No. of stations	Station nos.
Arsenic	1	13	12	9,12,21,36,43,53,57,64,67,82,87,102
Cadmium	0		18	4,12,14,22,27,29,31,45,47,49,55,57,74,78,96,102,105,116
Copper	3	88,111,115	19	1,5,8,9,12,14,39,44,45,47,53,54,67,68,69,70,78,96,116
Mercury	3	57,75,114	6	6,13,15,21,40,78
Lead	0		24	1,4,9,15,21,45,49,51,53,57,70,72,81,84,86,87,88,89,96,98, 102,103,105,116
Selenium	1	76	16	1,5,8,9,10,44,51,53,54,57,68,73,75,96,101,116
Zinc	13	13,21,28,33,39,40,59,76,79,89,102,103,107	25	1,2,4,5,7,8,9,12,20,23,32,44,45,53,54,67,68,69,70,80, 84,88,96,98,115

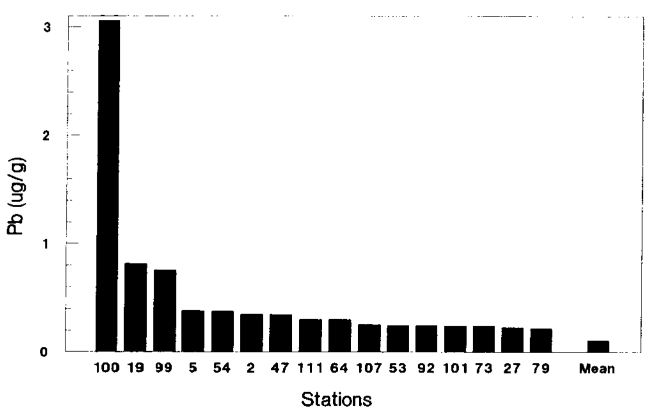

Fig. 2. Geometric mean concentrations of lead for NCBP stations at which the mean equaled or exceeded the 85th percentile concentration in 1984. Also shown is the national geometric mean for 1984

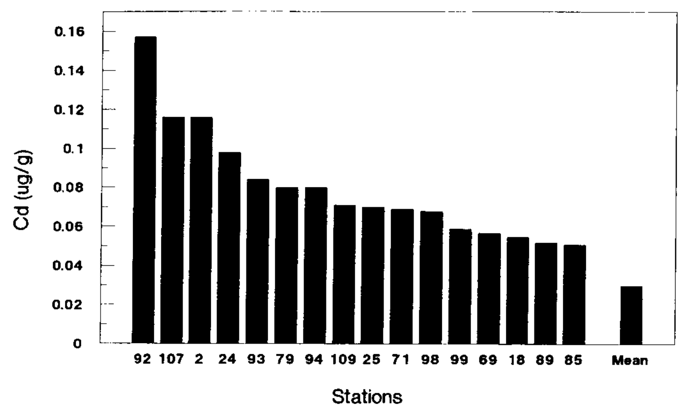

Fig. 3. Geometric mean concentrations of cadmium for NCBP stations at which the mean equaled or exceeded the 85th percentile concentration in 1984. Also shown is the national geometric mean for 1984

Mercury concentrations declined significantly at six stations during 1976–84 (Table 4); there is no history of mercury contamination at any of these stations, and concentrations in fish have been low. Conversely, mercury concentrations increased slightly from 1976–77 to 1984 at Station 57 (Altamaha R. at Doctortown, GA), where contamination has been attributed to a pulp-processing plant. At Station 37 (Truckee R. at Fernley, NV), elevated mercury concentrations have been attributed to gold mining, primarily of the Comstock Lode (Richins and Risser 1975). In the past, mercury concentrations also exceeded the 85th percentile in northern pike (*Esox lucius*) from Station 52 (Lake Champlain), from which the NCBP samples were not analyzed in 1984.

The highest mercury concentration in any single 1984 sample was in largemouth bass from Station 56 (Pee Dee R. at Johnsonville, SC; Table 3). May and McKinney (1981) reported that the Pee Dee River had a history of mercury contamination from paper manufacturing in Hartsville, SC.

Arsenic: Geometric mean concentrations of arsenic increased from 1972 to 1976–77 (May and McKinney 1981), but then declined 50%, mostly during 1976–79 (Table 2). Arsenic concentrations in NCBP samples have historically been highest in bloaters (*Coregonus hoyi*) from Station 21 (Lake Michigan at Sheboygan, WI), where concentrations also declined 50% from 1976–77 to 1984 (Table 3). Concentrations declined 50% or more in bloaters and lake trout (*Salvelinus namaycush*) at all Lake Michigan stations (21, 104, and 105—Appendix A). For Lake Michigan, the greatest single source of arsenic was a facility at Marinette, WI, on the Menominee R., that produced arsenical herbicides (May and McKinney 1981; Christensen and Chien 1981). The declining concentrations noted suggest that remedial activities at this site, which included discharge abatement and the removal of contaminated waste piles (Christensen and Chien 1981), have reduced the flux of arsenic to Lake Michigan. The 85th percentile for arsenic has not, however, shown any clear trend; after declining from 1976–77 through 1980–81, it increased in 1984 (Table 3).

Tests for temporal trends at individual stations indicated that arsenic concentrations declined significantly at 12 stations from 1976–77 to 1984 (Table 4); however, only four stations—21 and 102 (Lakes Michigan and Superior), 43 (Salmon R. at Riggins, ID), and 87 (North Platte R. at L. McConaughy, NE)—had been previously identified (May

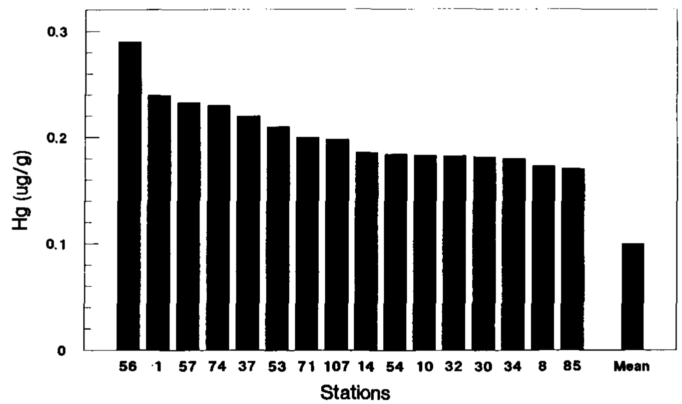

Fig. 4. Geometric mean concentrations of mercury for NCBP stations at which the mean equaled or exceeded the 85th percentile concentration in 1984. Also shown is the national geometric mean for 1984

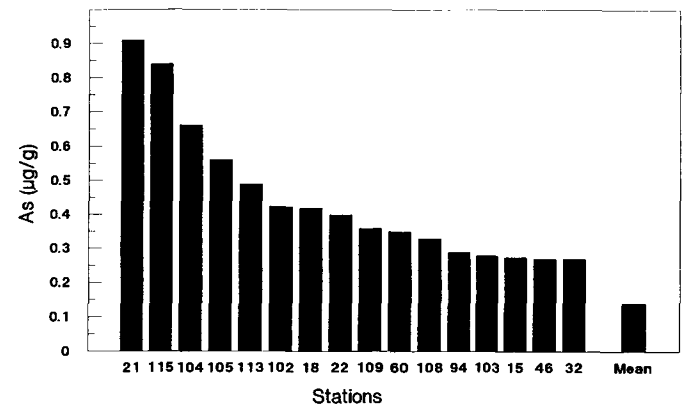

Fig. 5. Geometric mean concentrations of arsenic for NCBP stations at which the mean equaled or exceeded the 85th percentile concentration in 1984. Also shown is the national geometric mean for 1984

and McKinney 1981; Lowe *et al.* 1985) as possible problem spots (*i.e.*, exceeding the 85th percentile). As at the stations in Lake Michigan, arsenic concentrations in bloaters from Station 102 declined by more than 50% between 1976–77 and 1984. No lake trout were collected at this station in 1984 (Appendix A); however, concentrations in 1981 were lower than in previous collections (May and McKinney 1981; Lowe *et al.* 1985). At the other Lake Superior stations (22 and 103) bloaters have not been collected, and arsenic concentrations have not changed. (Table 4). Although arsenic concentrations increased at Station 13 (Apalachicola R. at the J. Woodruff Dam, FL; Table 4), they have been historically low (<0.25 µg/g).

In addition to Station 21, arsenic concentrations were again high in 1984 at other stations with a history of elevated levels. These included Station 115 (Colorado R. at Yuma, AZ), the other Lake Michigan stations (104 and 105), the three Lake Superior stations (22, 102, and 103), and Station 60 (Brazos R. at Richmond, TX). Elevated arsenic concentrations at Station 115 may have resulted from the use of arsenical agricultural chemicals in the intensively farmed regions of the lower Colorado River watershed. The increase in arsenic concentrations at Stations 18 and 109 (Lake Ontario) in 1984 were probably due largely or entirely to a change in the species composition of the samples; lake trout and slimy sculpins (*Cottus cognatus*) were collected at these stations in 1984 (Appendix A), whereas other species, with lower concentrations, had been collected in earlier years. Wagemann *et al.* (1978) reported that slimy sculpins readily accumulate arsenic. Arsenic concentrations in lake trout from Station 106 (Lake Huron at Alpena, MI) have historically remained about the same as current levels in this species in Lakes Michigan, Ontario, and Superior (0.4–0.5 µg/g). Concentrations at Station 106 have never exceeded the 85th percentile, however, because white suckers and yellow perch have always been collected along with the lake trout, and arsenic concentrations in these two species have been low (<0.3 µg/g). At Station 113 (San Antonio R. at McFadden, TX), arsenic concentrations in longnose gar (*Lepisosteus osseus*) increased from 0.26 µg/g in 1980–81 to 0.49 µg/g—the fifth-highest—in 1984; however, this increase was based upon the analysis of only one 1984 sample.

Selenium: Nationally, the geometric mean concentration of selenium in fish declined slightly from 1978–81 to 1984 (Table 2). The maximum concentration in 1984, 2.30 µg/g in common carp from Station 36 (Colorado R. at Lake Martinez, AZ), was also slightly lower than in previous years (Table 3; Appendix A); however, the 85th percentile concentration did not change between 1978–79 and 1984 (Table 3). Of the 75 stations tested individually for temporal trends, selenium concentrations declined significantly at 16 and increased at 1 (Table 4); however, only at 3 of these 17 stations (Stations 5, Susquehanna R.; 10, Savannah R. at Savannah, GA; and 73, Des Moines R. at Keosauqua, IA) did concentrations exceed the 85th percentile in previous years (May and McKinney 1981; Lowe *et al.* 1985). At the others, selenium concentrations have generally been low. Seven stations at which the 85th percentile has historically been exceeded for selenium were not among those with data spanning four collection periods and were not tested for temporal trends: 35 (Green R. at Vernal, UT), 37 (Truckee R. at Fernley, NV), 38 (Utah Lake at Provo, UT), 65 (Pecos R. at Red Bluff Lake, TX), 91 and 92 (Colorado R. at L. Havasu and L. Mead, respectively), and 99 (Waikele Stream, Waipahu, HI). At five of these seven stations, selenium concentrations did not change appreciably from 1976–77 to 1984. Exceptions included Station 37, where selenium in Tahoe suckers (*Catostomus tahoensis*) increased from 0.19–0.35 µg/g in 1976–81 to 1.01–1.11 µg/g in 1984; and Station 91, where concentrations in common carp declined from 2.31–3.65 µg/g in 1978–79 to 1.29–1.89 µg/g in 1984.

The geographic distribution of stations with the greatest selenium concentrations changed little from 1976–77 to 1984; concentrations were highest in the arid areas of the western United States. All except 2 of the 16 stations with geometric mean concentrations above the 85th percentile in 1984 (Figure 6) also exceeded the 85th percentile in previous collections (May and McKinney 1981; Lowe *et al.* 1985). The exceptions were Station 97 (Columbia R. at Pasco, WA), where the 85th percentile concentration occurred (Figure 6), and where concentrations have not changed appreciably since 1978 (there are no 1976 data for Station 97); and Station 77 (Arkansas R. at John Martin Reservoir, CO), where the 1984 collection was the first since 1973.

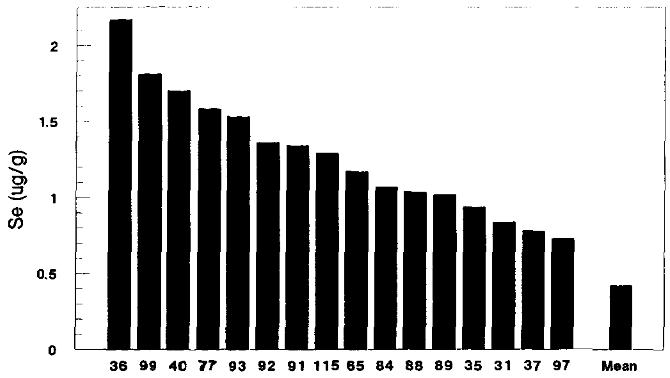

Fig. 6. Geometric mean concentrations of selenium for NCBP stations at which the mean equaled or exceeded the 85th percentile concentration in 1984. Also shown is the national geometric mean for 1984

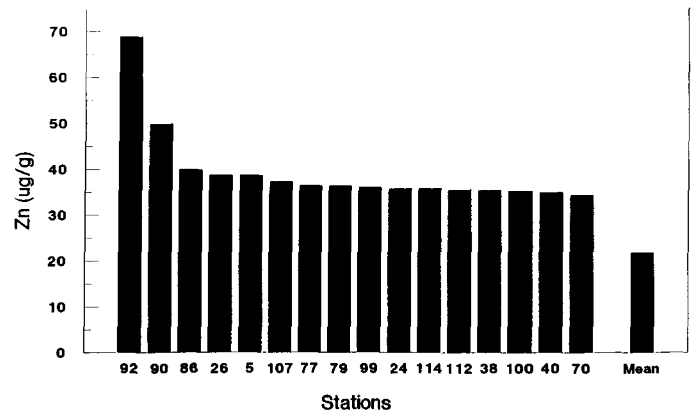

Fig. 7. Geometric mean concentrations of zinc for NCBP stations at which the mean equaled or exceeded the 85th percentile concentration in 1984. Also shown is the national geometric mean for 1984

Zinc: Although the geometric mean concentration of zinc declined from 1978–79 to 1980–81 (Lowe *et al.* 1985), there was no change from 1980–81 to 1984 (Table 2). Although the 85th percentile concentration for zinc declined steadily from 1976–77 to 1984, there was no discernable trend in the maximum concentration in the four collection periods (Table 3). As in previous years, concentrations of zinc were highest in the common carp, a species that apparently accumulates this element to a greater extent than other fishes (Lowe *et al.* 1985). Consequently, geographic and temporal trends are readily confounded by the presence or absence of common carp in collections from any point in space or time. This is illustrated by the trends at Stations 90 and 92, which had the highest geometric mean concentrations of zinc in 1984 (Figure 7) because only common carp were collected there (Appendix A). Previously, other species had also been collected at these stations, and the means were lower. At both stations, concentrations in common carp have ranged from 59 to 78 μg/g since 1979 (Appendix A; Lowe *et al.* 1981). Similarly, zinc in common carp from Station 107 (Lake St. Clair) increased from 13–15 μg/g in 1979 to 63–81 μg/g in 1981 (Lowe *et al.* 1985), and then to 95–118 μg/g in 1984 (Appendix A). In contrast, the range of zinc concentrations in walleyes collected at Station 107 for the three collection periods was 9–13 μg/g. The common carp samples from Station 107 contained the highest concentrations in the 1984 collection, and consequently caused Station 107 to be among those with the highest 1984 mean concentrations (Figure 7). Conversely, at the two stations where the maxima (>100 μg/g in common carp) occurred in 1978–79 (Station 35, Green R. at Vernal, UT) and 1980–81 (Station 38, Utah Lake, Provo, UT), concentrations in common carp declined to about 60 μg/g in 1984 (Appendix A). Only two stations where neither common carp nor goldfish were captured have exceeded the 85th percentile for zinc in any collection period (1978–79, 1980–81, or 1984); these were in Hawaii, where concentrations in 1984 were as high as 46.4 μg/g in Cuban limia and 48.7 μg/g in Chinese catfish, *Clarias fuscus* (Figure 7; Appendix A).

Lowe *et al.* (1985) reported that the mean concentration of zinc in common carp analyzed from 1976 to 1981 in the NCBP (63.4 μg/g) was significantly higher than the mean for all other species combined (16.5 μg/g). Concentrations exceeding 200 μg/g in common carp have been observed elsewhere (A. Ludden, U.S. Fish and Wildlife Service, Bismarck, ND, unpublished). Comparison of zinc concentrations in hatchery-reared fishes also suggests that common carp contain higher concentrations than other species. Common carp raised on commercial diets of different protein and energy contents contained 43.7 to 66.1 μg/g zinc (mean, 63.0 μg/g; Kirchgessner and Schwarz 1986). Hatchery-reared rainbow trout (*Oncorhynchus mykiss,* formerly *Salmo gairdneri*), however, typically contained only 25 μg/g of zinc (Shearer 1984). Carp gonads (both testis and ovary) also contained 3- to 4-fold higher concentrations of zinc than did those of rainbow trout (Satoh *et al.* 1987), suggesting that these tissues are important determinants of zinc differences among species. Zinc concentrations in goldfish (another introduced cyprinid that is closely related to the common carp) from Station 3 (Hudson R. at Poughkeepsie, NY) contained 58–67 μg/g in 1978 and 1980 (Lowe *et al.* 1985). These data suggest that goldfish also accumulate higher concentrations of zinc than do many other species for which we have data, including several native North American cyprinids. The greatest zinc concentration encountered in an NCBP sample of a species native to North America was 48 μg/g, in northern pike from Station 116 (Souris R. at Upham, ND). Because of the apparent extreme variability in zinc concentration among species, trends for zinc are best interpreted for individual stations, where concentrations in each species can be examined individually.

Copper: None of the indicator statistics (geometric mean, 85th percentile, or maximum concentration) for copper changed from 1980–81 to 1984, after a slight decline from 1978–79 to 1980–81 (Tables 2 and 3; Figure 8). The samples containing the highest concentrations of copper in 1984 were Mozambique tilapia (*Tilapia mossambica*) from Station 99, in Hawaii (Table 3), and white perch (*Morone americanus*) from the Susquehanna River (Station 5). These stations have historically yielded fish containing relatively high concentrations of copper. Lowe *et al.* (1985) noted that levels were

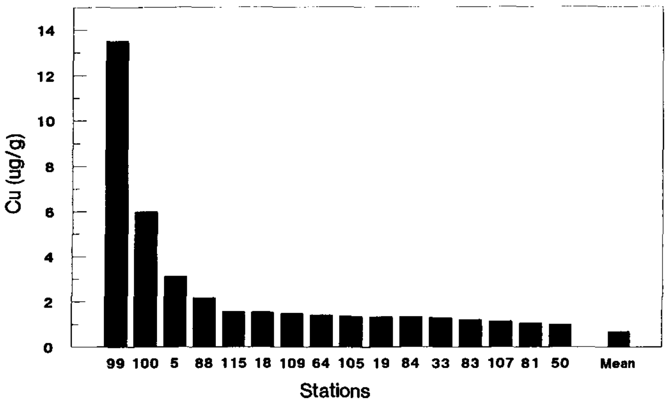

Fig. 8. Geometric mean concentrations of copper for NCBP stations at which the mean equaled or exceeded the 85th percentile concentration in 1984. Also shown is the national geometric mean for 1984

inexplicably high in white perch from the Susquehanna and Delaware Rivers, both of which are tidal in the reaches sampled for the NCBP. Marine fishes generally contain more copper than freshwater fishes, either because the $CuCl^+$ complex, which predominates in marine waters, is more available than the predominant forms in fresh waters (Moore and Ramamoorthy 1984); or because marine species prey on organisms that contain greater concentrations of copper than do freshwater organisms (Vinogradov 1953). The white perch inhabits both estuarine and fresh waters; it is also highly mobile, especially in spring before spawning (Bigelow and Schroeder 1953). Conversely, the closely related white bass (*Morone chrysops*), which inhabits only fresh water, has been collected from inland NCBP stations in previous years, but has never shown evidence of elevated copper concentrations (Lowe *et al.* 1985; May and McKinney 1981). Wiener and Giesy (1979) likewise found no significant differences in whole-body copper concentrations among seven freshwater species. Collectively, these findings suggest that factors related to the estuarine habitats frequented by white perch in coastal rivers are responsible for the elevated copper concentrations observed in this species. In Hawaii, however, the elevated concentrations in Mozambique tilapia and other fishes from Station 99 may derive from copper-containing pesticides; Waikele Stream at this station has a long history of contamination by herbicides and organochlorine insecticides from agriculture (Green *et al.* 1977; Schmitt *et al.* 1981, 1983, 1985).

Summary and Conclusions

Lead concentrations in fish declined significantly and steadily from 1976 to 1984. This finding agrees with trends reported for U.S. river water (Smith *et al.* 1987; Alexander and Smith 1988), riverine sediments (Trefry *et al.* 1985), and the atmosphere (Eisenreich *et al.* 1986) that have been attributed primarily to reductions in the lead content of motor fuels. Lead concentrations in fish also declined significantly at several stations influenced by mining and industrial discharges, suggesting that controls at these sources have also reduced the quantities of lead in the aquatic environment.

Mean concentrations of arsenic, cadmium, and selenium also declined from 1976 to 1984, but not nearly as much as those of lead. The decline was greater, however, than that of the overall mean at some stations where elevated levels were noted in the past; especially noteworthy were arsenic concentrations in fish from Lake Michigan, which declined by more than 50% from 1976–77 to 1984. Declining concentrations of arsenic and cadmium in fish contradicts the general trend of increasing concentrations of these elements noted for surface waters in 1974–81, which Smith *et al.* (1987) attributed to increasing U.S. coal combustion. Possible explanations for this apparent contradiction include: The dissolved species of these elements may not include all available chemical forms; the dissolved component may contain species that are not available for uptake by fish; concentrations in fish may not reflect concentrations in water; concentrations in water may have declined from 1981–84; or some combination of these alternatives. Collectively, the changes in arsenic concentrations noted for Lake Michigan, our findings of elevated cadmium concentrations in common carp from rivers that drain lead- and zinc-mining areas, and the decline since 1980–81 noted for selenium suggest that concentrations of these elements in water declined from 1981 to 1984, and tend to refute the alternative explanations. In contrast, concentrations of mercury, copper, and zinc have not changed since last reported by Lowe *et al.* (1985).

Acknowledgments. We appreciate the critical reviews provided by T. W. May, J. G. Wiener, and R. A. Smith, and the editorial comments of P. H. Eschmeyer. We also appreciate the assistance of S. Olson, G. Tegerdine, and A. Kazanas, who assisted with the preparation and analysis of the samples; G. Wylie, who performed the statistical analyses; A. Ludden, who shared unpublished data with us; and D. Lenhart, C. Sanchez, T. J. Miller, W. Johnson, A. Julin, E. Hansmann, and H. Metsker, who coordinated the collection and shipment of the fish samples.

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Manuscript received May 5, 1989 and in revised form June 10, 1989.

Appendix A. Concentrations of seven elements (μg/g, wet-weight) in whole fish, 1984. Fish names are as listed by the American Fisheries Society (1980) except for Cuban limia (*Poecilia vittata*) and Chinese catfish (*Clarias fuscus*). See Fig. 1 and Table 1 for locations of stations

Station	Species	Arsenic	Cadmium	Copper	Mercury	Lead	Selenium	Zinc	Moisture (%)
1	Smallmouth bass	0.08	0.01	0.38	0.33	0.10	0.19	12.64	74.1
1	White sucker	0.05	0.02	0.54	0.18	0.07	0.14	16.82	77.9
1	White sucker	0.07	0.02	0.57	0.14	0.11	0.15	18.34	76.4
2	White catfish	0.03	0.07	0.79	0.08	0.33	0.12	13.29	79.3
2	White catfish	0.07	0.07	0.84	0.04	0.28	0.13	12.72	77.6
2	Yellow perch	0.04	0.17	0.43	0.22	0.40	0.24	20.05	74.3
4	Largemouth bass	0.05	0.05	0.81	0.11	0.08	0.51	16.76	73.4
4	Smallmouth bass	0.10	0.04	0.65	0.12	0.08	0.69	16.75	73.5
4	White sucker	0.07	0.03	0.86	0.04	0.09	0.34	17.10	75.0
4	White sucker	0.09	0.03	0.84	0.05	0.13	0.45	17.79	75.4

Appendix A. (cont'd)

Station	Species	Arsenic	Cadmium	Copper	Mercury	Lead	Selenium	Zinc	Moisture (%)
5	Common carp	0.05	0.04	0.65	0.06	0.30	0.43	59.18	77.5
5	Common carp	0.07	0.03	0.66	0.05	0.33	0.35	59.30	79.9
5	White perch	0.15	0.03	9.19	0.06	0.45	0.66	25.20	77.7
6	Common carp	0.19	0.11	1.00	0.11	0.37	0.51	65.60	69.2
6	Common carp	0.15	0.07	1.11	0.07	0.21	0.51	55.74	73.2
6	Largemouth bass	0.03	0.00	0.88	0.12	0.07	0.49	13.75	77.2
7	Channel catfish	0.26	0.02	0.46	0.03	0.11	0.28	20.27	72.9
7	Channel catfish	0.24	0.02	0.39	0.03	0.12	0.33	19.92	72.3
7	Largemouth bass	0.08	0.01	0.51	0.25	0.24	0.38	13.94	73.5
8	Channel catfish	0.01	0.03	0.33	0.13	0.14	0.17	16.29	76.7
8	Largemouth bass	0.03	0.01	0.28	0.22	0.16	0.28	14.41	76.8
9	Channel catfish	0.05	0.01	0.25	0.04	0.07	0.28	23.74	76.5
9	Channel catfish	0.03	0.01	0.55	0.03	0.07	0.28	21.14	76.9
9	Largemouth bass	0.04	0.00	0.46	0.13	0.10	0.36	13.62	76.4
10	Channel catfish	0.08	0.02	0.47	0.14	0.05	0.25	16.83	76.2
10	Channel catfish	0.12	0.02	0.44	0.12	0.07	0.15	18.39	77.9
10	Largemouth bass	0.11	0.03	0.70	0.24	0.02	0.32	12.22	73.5
12	Largemouth bass	0.08	0.00	0.59	0.13	0.03	0.27	15.28	75.0
12	Largemouth bass	0.13	0.00	0.33	0.14	0.07	0.31	13.26	74.8
12	White catfish	0.09	0.01	0.70	0.05	0.15	0.16	19.63	74.2
12	White catfish	0.08	0.01	0.78	0.06	0.07	0.22	22.65	75.7
13	Largemouth bass	0.16	0.01	0.25	0.19	0.05	0.17	12.03	68.1
13	Spotted sucker	0.08	0.02	0.55	0.09	0.18	0.36	19.72	70.3
13	Spotted sucker	0.15	0.05	0.67	0.07	0.09	0.40	21.05	68.9
14	Channel catfish	0.03	0.01	0.24	0.13	0.07	0.20	20.84	77.0
14	Channel catfish	0.03	0.01	0.44	0.06	0.58	0.34	28.32	69.9
14	Largemouth bass	0.04	0.00	0.36	0.29	0.02	0.27	12.86	73.8
15	Gizzard shad	0.25	0.02	0.89	0.01	0.07	0.37	12.44	75.7
15	Gizzard shad	0.31	0.02	0.65	0.01	0.06	0.42	15.88	73.8
15	White bass	0.27	0.01	0.06	0.04	0.02	0.62	16.43	70.5
16	Channel catfish	0.10	0.01	0.24	0.05	0.05	0.29	18.58	81.6
16	Channel catfish	0.08	0.01	0.30	0.06	0.06	0.30	20.42	78.8
16	Gizzard shad	0.53	0.01	0.64	0.03	0.27	0.53	12.09	72.2
16	Gizzard shad	0.49	0.02	0.61	0.03	0.25	0.66	13.78	73.5
16	Largemouth bass	0.11	0.01	0.31	0.18	0.07	0.44	13.22	76.4
17	Largemouth bass	0.10	0.00	0.35	0.11	0.03	0.27	13.39	76.3
17	Redhorse	0.06	0.01	0.53	0.06	0.18	0.22	18.83	76.7
17	Redhorse	0.06	0.01	0.50	0.06	0.17	0.24	18.44	77.4
18	Lake trout	0.46	0.00	1.05	0.15	0.09	0.45	10.14	71.1
18	Lake trout	0.78	0.02	2.49	0.22	0.03	0.48	9.60	63.5
18	Slimy sculpin	0.26	0.10	1.43	0.12	0.23	0.51	15.43	79.7
19	White sucker	0.17	0.05	1.15	0.04	0.07	0.42	15.13	76.5
19	White sucker	0.20	0.05	1.10	0.05	0.12	0.41	14.74	75.1
19	Yellow perch	0.08	0.02	1.60	0.04	2.02	0.48	17.87	74.9
20	Common carp	0.15	0.05	1.21	0.08	0.15	0.62	53.46	70.3
20	Common carp	0.13	0.03	1.28	0.06	0.22	0.58	52.02	69.4
20	Yellow perch	0.05	0.01	0.44	0.09	0.04	0.36	17.62	74.2
21	Bloater	1.51	0.02	0.73	0.04	0.08	0.32	16.83	63.1
21	Bloater	1.38	0.02	0.75	0.04	0.07	0.36	19.71	64.1
21	Lake trout	0.50	0.00	0.78	0.09	0.09	0.32	10.42	70.4
22	Bloater	0.59	0.02	0.47	0.06	0.01	0.37	16.34	70.3
22	Bloater	0.58	0.02	0.58	0.04	0.09	0.43	17.08	70.3
22	Lake trout	0.24	0.00	0.86	0.13	0.01	0.48	12.78	70.0
23	Channel catfish	0.06	0.01	0.40	0.08	0.08	0.21	14.85	73.3

Appendix A. (cont'd)

Station	Species	Arsenic	Cadmium	Copper	Mercury	Lead	Selenium	Zinc	Moisture (%)
23	Sauger	0.12	0.00	0.31	0.17	0.03	0.36	15.65	72.5
23	Striped bass	0.29	0.00	1.54	0.08	0.06	0.39	13.90	71.4
23	Striped bass	0.22	0.00	1.64	0.10	0.08	0.49	13.03	73.3
23	White crappie	0.18	0.00	0.35	0.05	0.07	0.25	13.24	76.9
24	Common carp	0.31	0.20	1.36	0.07	0.22	0.67	79.62	70.4
24	White crappie	0.1	0.01	0.26	0.03	0.02	0.28	15.77	77.5
25	Common carp	0.06	0.17	1.03	0.09	0.37	0.49	65.15	73.3
25	Common carp	0.08	0.11	0.87	0.07	0.32	0.47	61.95	74.4
25	Spotted bass	0.12	0.00	0.37	0.09	0.02	0.26	13.28	77.6
26	Black crappie	0.24	0.00	0.41	0.05	0.09	0.29	18.21	73.8
26	Common carp	0.08	0.05	0.92	0.06	0.26	0.42	69.89	68.8
26	Common carp	0.08	0.04	1.24	0.06	0.17	0.41	94.25	69.5
27	Black crappie	0.08	0.01	0.27	0.05	0.47	0.43	15.07	72.9
27	Common carp	0.09	0.02	1.00	0.06	0.01	0.42	77.98	69.3
27	Common carp	0.06	0.03	0.90	0.08	0.07	0.46	69.01	68.2
28	Common carp	0.09	0.03	0.94	0.06	0.06	0.31	58.17	71.9
28	Common carp	0.12	0.03	0.78	0.06	0.10	0.33	74.00	70.4
28	Largemouth bass	0.12	0.00	0.40	0.04	0.01	0.22	12.75	74.8
29	Common carp	0.13	0.08	0.62	0.10	0.17	0.57	62.98	72.5
29	Common carp	0.08	0.06	0.61	0.10	0.17	0.51	66.55	73.8
29	Largemouth bass	0.27	0.00	0.43	0.08	0.01	0.38	13.86	73.3
30	Bigmouth buffalo	0.15	0.02	0.88	0.26	0.09	0.31	14.86	71.8
30	Bigmouth buffalo	0.11	0.03	0.53	0.26	0.08	0.30	15.83	70.9
30	Longear sunfish	0.08	0.02	0.30	0.11	0.05	0.40	22.32	76.0
31	Common carp	0.04	0.07	1.07	0.04	0.04	0.83	60.20	74.6
31	Common carp	0.05	0.06	0.82	0.03	0.07	0.84	58.33	69.3
31	Sauger	0.09	0.00	0.44	0.07	0.02	0.86	12.67	74.4
32	River carpsucker	0.19	0.04	0.56	0.08	0.13	0.79	12.83	61.7
32	River carpsucker	0.22	0.03	0.70	0.09	0.09	0.74	14.03	60.7
32	Walleye	0.34	0.01	0.37	0.29	0.01	0.35	11.84	67.3
33	Brown trout	0.03	0.01	1.86	0.14	0.01	0.64	27.67	73.9
33	Longnose sucker	0.30	0.10	0.88	0.12	0.22	0.26	21.65	68.4
33	Longnose sucker	0.24	0.06	0.86	0.09	0.33	0.28	19.86	69.5
34	Common carp	0.05	0.10	1.03	0.11	0.04	0.47	55.58	68.6
34	Common carp	0.04	0.08	1.46	0.11	0.06	0.47	65.09	71.7
34	Sauger	0.02	0.00	0.45	0.26	0.01	0.24	15.51	73.4
35	Common carp	0.03	0.05	0.87	0.11	0.08	0.64	60.27	75.6
35	Common carp	0.05	0.04	0.86	0.09	0.05	1.74	57.04	77.0
35	Smallmouth bass	0.04	0.00	0.38	0.20	0.03	0.78	12.53	72.7
36	Common carp	0.07	0.02	1.01	0.02	0.15	2.30	57.86	74.4
36	Common carp	0.07	0.02	0.59	0.02	0.15	2.30	57.20	74.4
36	Largemouth bass	0.06	0.00	0.39	0.04	0.03	2.08	17.82	75.0
37	Green sunfish	0.11	0.00	0.50	0.27	0.01	0.54	17.11	75.1
37	Tahoe sucker	0.15	0.01	0.90	0.20	0.06	1.11	19.92	74.3
37	Tahoe sucker	0.14	0.01	0.83	0.13	0.05	1.01	21.10	77.7
38	Common carp	0.14	0.01	0.90	0.02	0.05	0.41	57.80	75.3
38	Common carp	0.17	0.00	0.60	0.03	0.02	0.47	67.23	75.1
38	White bass	0.05	0.00	1.22	0.08	0.06	0.53	19.82	77.6
39	Common carp	0.06	0.01	0.69	0.02	0.07	0.32	52.76	78.2
39	Common carp	0.13	0.00	0.56	0.03	0.05	0.38	56.75	77.3
39	White crappie	0.08	0.00	0.17	0.07	0.01	0.21	16.61	77.7
40	Common carp	0.07	0.00	0.48	0.03	0.03	1.47	38.02	78.4
40	Common carp	0.05	0.00	0.35	0.01	0.02	1.94	31.88	79.3
41	Largescale sucker	0.06	0.01	0.60	0.06	0.09	0.33	13.29	78.7

Appendix A. (cont'd)

Station	Species	Arsenic	Cadmium	Copper	Mercury	Lead	Selenium	Zinc	Moisture (%)
41	Largescale sucker	0.09	0.00	0.49	0.03	0.05	0.37	15.45	77.7
41	Rainbow trout	0.28	0.00	1.06	0.04	0.02	0.45	26.20	76.4
42	Largescale sucker	0.15	0.02	0.90	0.16	0.19	0.20	22.36	77.6
42	Largescale sucker	0.19	0.02	0.85	0.10	0.15	0.22	19.07	74.5
42	Northern squawfish	0.05	0.01	0.58	0.14	0.01	0.30	20.27	73.4
43	Largescale sucker	0.10	0.02	0.64	0.12	0.14	0.32	20.48	78.4
43	Largescale sucker	0.13	0.02	1.04	0.08	0.17	0.28	21.48	76.8
43	Mountain whitefish	0.12	0.04	0.84	0.09	0.07	0.68	24.79	75.7
44	Black crappie	0.25	0.00	0.27	0.17	0.04	0.40	26.88	74.4
44	Largescale sucker	0.16	0.00	0.43	0.07	0.03	0.36	18.83	77.4
44	Largescale sucker	0.14	0.00	0.46	0.06	0.05	0.35	18.12	78.5
45	Northern squawfish	0.30	0.00	0.57	0.21	0.03	0.25	16.35	79.3
45	Peamouth	0.07	0.01	0.50	0.05	0.08	0.11	17.48	77.5
45	Peamouth	0.06	0.01	0.59	0.04	0.05	0.13	17.55	78.6
46	Largescale sucker	0.22	0.04	1.01	0.10	0.09	0.24	20.79	71.4
46	Northern squawfish	0.32	0.05	0.97	0.07	0.04	0.35	21.17	71.2
47	Yellow bullhead	0.02	0.00	0.38	0.07	0.57	0.15	12.02	78.3
47	Yellow bullhead	0.02	0.01	1.15	0.23	0.07	0.21	19.02	68.2
47	Yellow perch	0.02	0.01	0.32	0.10	0.40	0.16	19.16	76.2
48	Black crappie	0.23	0.00	0.38	0.12	0.02	0.11	17.43	75.0
48	Largescale sucker	0.07	0.01	1.01	0.06	0.02	0.11	19.56	75.3
48	Largescale sucker	0.04	0.00	0.60	0.06	0.05	0.08	18.01	77.6
49	Arctic grayling	0.02	0.01	0.58	0.06	0.04	0.58	17.65	76.9
49	Longnose sucker	0.11	0.01	0.57	0.06	0.06	0.33	14.90	80.7
50	Longnose sucker	0.28	0.00	0.89	0.04	0.01	0.20	22.16	77.8
50	Rainbow trout	0.08	0.00	1.13	0.02	0.01	0.17	37.35	76.8
51	White sucker	0.10	0.02	0.50	0.15	0.06	0.19	16.31	79.2
51	White sucker	0.04	0.01	0.49	0.14	0.04	0.15	14.71	79.8
51	Yellow perch	0.06	0.02	0.42	0.12	0.05	0.18	14.41	76.9
53	Smallmouth bass	0.04	0.02	0.34	0.23	0.14	0.26	12.91	72.3
53	White sucker	0.04	0.06	0.59	0.18	0.36	0.19	19.06	73.0
53	White sucker	0.04	0.10	0.67	0.21	0.38	0.20	19.61	72.8
54	Redear sunfish	0.24	0.07	0.87	0.18	0.56	0.59	24.99	79.0
54	White sucker	0.04	0.03	1.31	0.17	0.22	0.35	19.91	73.6
54	White sucker	0.04	0.03	0.99	0.20	0.21	0.28	19.61	75.7
55	Largemouth bass	0.01	0.00	0.35	0.12	0.01	0.35	13.99	74.1
55	Redhorse	0.04	0.03	0.53	0.07	0.07	0.31	14.64	69.5
55	Redhorse	0.04	0.07	0.44	0.10	0.07	0.30	14.63	70.2
56	Channel catfish	0.02	0.01	0.26	0.21	0.10	0.20	18.52	77.9
56	Channel catfish	0.02	0.01	0.39	0.21	0.05	0.21	19.79	77.3
56	Largemouth bass	0.03	0.00	0.29	0.37	0.02	0.27	12.50	71.4
57	Largemouth bass	0.02	0.01	0.84	0.25	0.06	0.28	14.24	72.3
57	Spotted sucker	0.04	0.02	0.62	0.19	0.03	0.35	16.22	72.7
57	Spotted sucker	0.02	0.03	1.01	0.25	0.20	0.38	19.13	70.7
59	Channel catfish	0.03	0.01	0.32	0.07	0.03	0.22	19.43	73.6
59	Channel catfish	0.02	0.02	0.51	0.05	0.08	0.36	32.66	68.6
59	Largemouth bass	0.05	0.01	1.27	0.22	0.06	0.26	11.43	71.2
60	Carpsucker	0.21	0.02	0.73	0.04	0.35	0.27	16.21	77.2
60	Channel catfish	0.03	0.02	0.31	0.02	0.04	0.39	27.13	79.6
60	Gizzard shad	0.50	0.01	0.80	0.02	0.25	0.24	12.02	77.2
60	Striped mullet	0.80	0.00	1.73	0.01	0.04	0.28	12.37	73.8
62	Gizzard shad	0.16	0.02	0.70	0.04	0.11	0.31	12.90	73.3
62	Gizzard shad	0.17	0.02	0.52	0.03	0.14	0.32	15.06	75.9
62	White bass	0.15	0.01	0.23	0.08	0.01	0.25	15.07	73.8

Appendix A. (cont'd)

Station	Species	Arsenic	Cadmium	Copper	Mercury	Lead	Selenium	Zinc	Moisture (%)
63	Common carp	0.11	0.06	0.72	0.09	0.26	0.31	43.88	78.7
63	Common carp	0.06	0.09	0.74	0.14	0.25	0.27	61.10	81.2
63	Largemouth bass	0.27	0.00	0.53	0.12	0.01	0.36	13.85	75.4
64	Brown trout	0.04	0.08	2.25	0.08	0.41	0.33	32.46	77.3
64	White sucker	0.05	0.01	0.98	0.02	0.24	0.35	24.39	74.3
64	White sucker	0.04	0.01	0.65	0.01	0.16	0.18	16.64	81.3
65	Gizzard shad	0.29	0.02	0.70	0.01	0.40	0.77	13.10	75.0
65	Gizzard shad	0.29	0.02	0.75	0.01	0.34	1.00	14.25	74.6
65	White bass	0.24	0.00	0.94	0.06	0.06	1.50	14.24	72.3
67	Largemouth bass	0.06	0.01	0.54	0.07	0.05	0.39	14.31	76.8
67	Redhorse	0.07	0.06	0.64	0.04	0.12	0.39	19.36	76.9
67	Redhorse	0.06	0.04	0.46	0.05	0.08	0.43	20.24	75.7
68	Common carp	0.13	0.05	1.07	0.08	0.19	0.48	69.93	68.5
68	Common carp	0.10	0.07	1.02	0.10	0.15	0.47	61.29	69.2
68	White crappie	0.11	0.00	0.21	0.07	0.01	0.26	16.66	75.5
69	Common carp	0.07	0.08	0.91	0.03	0.26	0.71	50.96	72.0
69	Common carp	0.11	0.14	0.94	0.04	0.36	0.73	63.36	71.2
69	Sauger	0.11	0.01	0.36	0.09	0.03	0.33	17.52	70.7
70	Common carp	0.37	0.08	0.80	0.07	0.10	0.41	62.67	70.3
70	Common carp	0.29	0.09	0.79	0.09	0.10	0.45	69.20	70.8
70	White crappie	0.20	0.01	0.41	0.16	0.05	0.22	17.58	75.1
71	Black crappie	0.10	0.01	0.14	0.20	0.02	0.25	17.80	76.2
71	Common carp	0.10	0.15	0.88	0.21	0.28	0.52	56.03	72.8
71	Common carp	0.12	0.13	0.88	0.19	0.20	0.51	59.62	72.9
72	Common carp	0.05	0.04	1.04	0.15	0.07	0.29	58.40	74.5
72	Common carp	0.06	0.03	1.13	0.14	0.05	0.27	62.93	72.4
72	Smallmouth bass	0.07	0.00	0.53	0.08	0.05	0.24	12.53	76.4
73	Common carp	0.14	0.07	1.12	0.06	0.17	0.55	66.06	70.9
73	Common carp	0.06	0.07	0.92	0.06	0.17	0.61	53.11	71.9
73	Walleye	0.33	0.01	0.65	0.04	0.32	0.49	12.90	74.9
74	Northern pike	0.03	0.00	0.43	0.26	0.05	0.17	36.29	77.6
74	White sucker	0.03	0.01	1.07	0.20	0.03	0.20	15.48	77.6
74	White sucker	0.01	0.02	1.06	0.20	0.01	0.16	13.41	79.3
75	Common carp	0.07	0.10	1.02	0.11	0.10	0.59	58.03	68.8
75	Common carp	0.07	0.06	0.86	0.10	0.07	0.47	65.00	67.5
75	White crappie	0.30	0.01	0.16	0.13	0.02	0.24	13.13	73.1
76	Common carp	0.05	0.05	0.63	0.07	0.16	0.51	42.08	74.8
76	Common carp	0.07	0.04	0.85	0.06	0.05	0.38	66.92	76.1
76	White crappie	0.14	0.01	0.20	0.16	0.07	0.30	18.23	75.5
77	Black crappie	0.39	0.00	0.26	0.00	0.05	2.14	16.53	75.9
77	Black crappie	0.07	0.01	0.62	0.02	0.05	1.30	22.58	75.9
77	Common carp	0.05	0.03	0.68	0.01	0.07	0.87	70.47	73.9
77	Common carp	0.18	0.02	0.81	0.04	0.08	2.28	65.54	74.5
78	Common carp	0.03	0.04	0.62	0.03	0.07	0.48	66.72	76.0
78	Common carp	0.04	0.02	0.47	0.04	0.12	0.46	59.78	75.7
78	Largemouth bass	0.46	0.02	0.41	0.03	0.18	0.49	12.51	72.8
79	Common carp	0.09	0.21	0.89	0.07	0.38	0.43	79.76	74.6
79	Common carp	0.10	0.11	0.90	0.07	0.39	0.45	54.24	76.0
79	Largemouth bass	0.14	0.01	0.42	0.10	0.07	0.28	19.93	75.4
80	Smallmouth buffalo	0.09	0.02	0.46	0.10	0.09	0.41	18.03	70.1
80	White crappie	0.18	0.01	0.37	0.17	0.02	0.29	13.65	74.0
81	Channel catfish	0.05	0.01	0.34	0.02	0.08	0.18	18.62	74.5
81	Channel catfish	0.08	0.01	0.37	0.02	0.05	0.21	16.60	77.2
81	White crappie	0.10	0.00	2.19	0.08	0.07	0.33	18.11	69.3

Appendix A. (cont'd)

Station	Species	Arsenic	Cadmium	Copper	Mercury	Lead	Selenium	Zinc	Moisture (%)
82	Common carp	0.07	0.03	0.77	0.03	0.06	0.47	47.24	73.9
82	Common carp	0.06	0.03	0.77	0.09	0.09	0.51	67.98	70.7
82	Largemouth bass	0.13	0.00	0.36	0.03	0.05	0.40	15.93	77.6
83	Freshwater drum	0.12	0.02	2.19	0.08	0.07	0.84	12.25	69.3
83	Quillback carpsucker	0.16	0.02	0.57	0.08	0.10	0.44	14.55	67.0
83	Quillback carpsucker	0.09	0.02	0.54	0.06	0.11	0.38	13.44	64.9
84	Brown trout	0.04	0.01	2.34	0.12	0.12	1.49	23.69	70.9
84	Longnose sucker	0.10	0.01	0.59	0.06	0.09	0.74	19.04	70.8
84	Longnose sucker	0.09	0.01	0.71	0.08	0.06	0.74	17.76	70.7
85	Common carp	0.05	0.14	0.90	0.13	0.09	0.65	71.96	75.1
85	Common carp	0.05	0.05	1.11	0.10	0.06	0.62	57.23	77.2
85	Sauger	0.13	0.01	0.28	0.23	0.08	0.42	13.52	73.7
86	Common carp	0.06	0.04	0.95	0.09	0.08	0.41	83.02	72.6
86	Common carp	0.05	0.04	0.80	0.06	0.08	0.68	74.10	71.5
86	Goldeye	0.03	0.02	0.65	0.18	0.15	0.73	20.07	66.6
87	Common carp	0.17	0.10	0.79	0.11	0.08	0.90	69.17	73.6
87	Common carp	0.05	0.01	0.65	0.02	0.09	0.67	39.58	79.6
87	Walleye	0.18	0.00	0.31	0.04	0.00	0.50	11.82	77.9
88	Mixed species	0.10	0.01	2.17	0.05	0.06	1.04	24.79	74.2
89	Carpsucker	0.13	0.02	0.71	0.05	0.09	0.84	15.26	71.1
89	Carpsucker	0.05	0.15	0.91	0.12	0.30	0.78	15.47	69.6
89	Goldeye	0.03	0.02	0.49	0.15	0.14	1.25	23.29	67.1
90	Common carp	0.09	0.03	0.70	0.05	0.08	0.65	53.20	71.7
90	Common carp	0.07	0.04	1.06	0.07	0.14	0.55	46.67	74.5
91	Common carp	0.14	0.04	0.96	0.04	0.19	1.88	67.34	74.0
91	Common carp	0.14	0.02	0.84	0.04	0.28	1.29	47.17	77.1
91	Largemouth bass	0.26	0.01	0.32	0.02	0.02	1.13	13.96	75.8
92	Common carp	0.12	0.13	0.85	0.07	0.24	1.36	61.00	79.8
92	Common carp	0.08	0.18	0.92	0.07	0.25	1.35	77.74	77.4
93	Common carp	0.09	0.18	0.95	0.08	0.28	1.61	66.68	77.7
93	Common carp	0.10	0.17	1.14	0.09	0.43	1.78	64.99	75.1
93	Largemouth bass	0.21	0.00	0.67	0.18	0.08	1.37	13.80	74.3
94	Common carp	0.14	0.16	0.92	0.10	0.17	0.37	46.23	77.0
94	Common carp	0.18	0.16	1.15	0.08	0.25	0.38	50.34	79.2
94	Largemouth bass	0.43	0.01	0.88	0.18	0.02	0.52	13.38	71.9
96	Largescale sucker	0.25	0.01	0.71	0.03	0.13	0.23	14.11	77.6
96	Largescale sucker	0.20	0.01	0.61	0.03	0.10	0.21	16.26	76.9
96	White crappie	0.12	0.01	0.52	0.06	0.04	0.22	15.64	74.7
97	Yellow perch	0.07	0.01	0.48	0.03	0.07	1.05	27.06	66.0
97	Peamouth	0.08	0.03	0.75	0.02	0.09	0.45	24.59	71.1
97	Peamouth	0.07	0.03	1.08	0.03	0.05	0.47	19.69	71.3
98	Largescale sucker	0.17	0.17	1.15	0.13	0.40	0.20	23.91	75.7
98	Largescale sucker	0.11	0.05	0.94	0.06	0.16	0.25	18.53	77.1
98	Walleye	0.10	0.03	0.30	0.08	0.03	0.22	12.70	77.8
99	Cuban limia	0.12	0.06	8.54	0.04	0.76	1.56	46.40	68.0
99	Mozambique tilapia	0.14	0.06	23.1	0.03	0.92	1.98	28.47	71.1
99	Mozambique tilapia	0.12	0.06	19.2	0.03	0.62	2.20	27.33	69.6
100	Cuban limia	0.34	0.03	5.56	0.03	4.88	0.28	29.61	71.8
100	Mozambique tilapia	0.32	0.04	10.9	0.03	3.95	0.31	30.03	71.4
100	Chinese catfish	0.06	0.02	3.38	0.08	1.30	0.29	48.66	68.4
101	White sucker	0.06	0.02	0.86	0.11	0.22	0.17	18.65	79.0
101	White sucker	0.04	0.01	1.13	0.10	0.26	0.19	18.57	76.4
101	Yellow perch	0.03	0.02	0.48	0.16	0.25	0.18	16.54	76.3

Appendix A. (cont'd)

Station	Species	Arsenic	Cadmium	Copper	Mercury	Lead	Selenium	Zinc	Moisture (%)
102	Bloater	0.45	0.02	0.38	0.07	0.08	0.37	14.70	71.9
102	Bloater	0.40	0.02	0.70	0.06	0.03	0.35	18.66	76.5
103	Lake whitefish	0.33	0.04	1.14	0.05	0.08	0.56	15.68	73.1
103	Lake whitefish	0.24	0.04	0.47	0.05	0.08	0.60	15.99	72.9
104	Bloater	0.97	0.02	0.34	0.04	0.05	0.37	17.14	66.0
104	Bloater	1.10	0.02	0.34	0.04	0.07	0.29	14.60	69.2
104	Lake trout	0.36	0.01	0.81	0.08	0.09	0.46	11.75	70.4
105	Lake trout	0.56	0.01	1.39	0.15	0.02	0.44	12.21	65.2
106	Lake trout	0.43	0.01	0.86	0.20	0.10	0.52	11.12	64.7
106	White sucker	0.07	0.02	0.66	0.05	0.18	0.44	14.78	76.0
106	White sucker	0.09	0.01	0.79	0.04	0.12	0.47	14.81	75.4
107	Common carp	0.15	0.22	1.99	0.20	0.57	0.79	118.4	67.9
107	Common carp	0.11	0.21	1.65	0.21	0.43	0.74	95.13	69.8
107	Walleye	0.28	0.03	0.64	0.20	0.05	0.55	12.72	70.0
108	Walleye	0.33	0.03	0.93	0.11	0.02	0.34	11.53	71.1
109	Lake trout	0.42	0.01	1.28	0.12	0.04	0.72	12.91	70.4
109	Slimy sculpin	0.30	0.14	1.73	0.10	0.08	0.51	15.33	73.2
111	Common carp	0.14	0.02	0.96	0.03	0.06	0.41	65.85	75.7
111	Common carp	0.18	0.04	1.49	0.03	1.37	0.42	77.81	73.8
111	Walleye	0.10	0.01	0.68	0.08	0.08	0.33	11.30	74.5
112	Black crappie	0.06	0.00	0.31	0.03	0.04	0.44	15.85	75.8
112	Common carp	0.08	0.02	0.97	0.04	0.08	0.47	71.54	72.8
112	Common carp	0.06	0.04	1.05	0.08	0.07	0.58	84.86	68.8
113	Longnose gar	0.49	0.02	0.56	0.17	0.05	0.36	22.70	65.4
114	Common carp	0.06	0.01	0.80	0.04	0.06	0.26	51.00	79.1
114	Common carp	0.07	0.01	0.55	0.04	0.04	0.26	42.55	78.4
114	Green sunfish	0.06	0.01	0.49	0.09	0.22	0.34	27.39	74.4
115	Largemouth bass	0.49	0.00	0.63	0.09	0.09	1.10	14.07	70.5
115	Striped mullet	1.13	0.01	3.00	0.01	0.34	1.61	13.32	63.3
115	Striped mullet	1.44	0.02	3.15	0.01	0.36	1.39	13.68	64.2
116	Northern pike	0.04	0.00	0.57	0.13	0.02	0.18	39.35	79.4
116	White sucker	0.10	0.00	0.78	0.08	0.03	0.22	13.07	78.5
116	White sucker	0.06	0.00	0.68	0.10	0.07	0.22	15.00	76.3
117	Largescale sucker	0.06	0.02	0.91	0.21	0.05	0.18	20.81	76.8
117	Largescale sucker	0.09	0.02	0.82	0.14	0.08	0.18	19.39	75.3
117	Mountain whitefish	0.09	0.01	0.48	0.05	0.07	0.32	21.91	77.2